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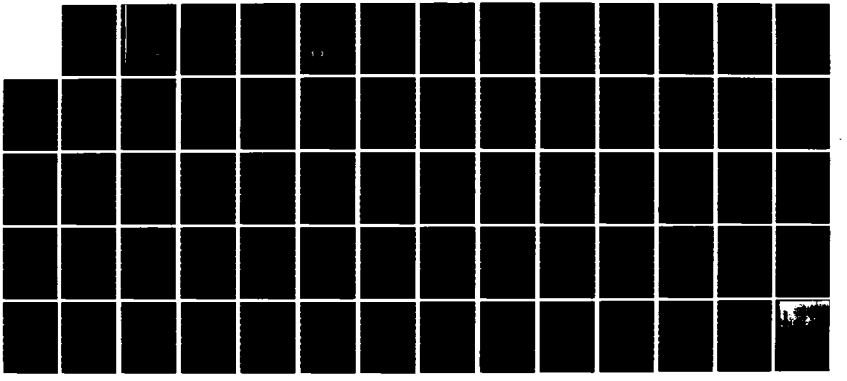

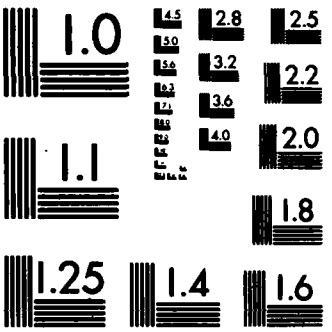

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A GUIDE TO OCEANIC SEDIMENTARY LAYERING

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Technical Report

Prepared for:

NAVAL OCEAN RESEARCH
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study locations
cores
seafloor spreading studies
seismic reflection and refraction
detailed bathymetry
sedimentation and deposition
post-depositional effects

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report organizes a vast amount of the available scientific literature treating the layering structure of marine sediments. The major areas covered are the North Atlantic and North Pacific Oceans. The report contains a user's guide and a useful cross-referenced bibliography. The user's guide organizes the contents of the bibliographic cross-reference system. The bibliographic cross-reference has twelve divisions, with numerous subdivisions. Papers are cross-referenced with respect to study locations, cores, seafloor spreading

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studies, seismic reflection and refraction, detailed bathymetry, maps, cross sections, geological history, processes of sedimentation and deposition, post-depositional effects, and sediment and rock properties.

TABLE OF CONTENTS

I. INTRODUCTION

This guide provides and organizes a cross-referenced bibliography of literature describing the layering found in marine sediments. The list of references used is not exhaustive; however, many of the most recent articles have been abstracted from the literature and their references should provide adequate coverage of any subject within the purview of this work. The specific issue addressed is the nature and extent of sedimentary layering in the deep ocean, with a view toward specific application to the study of acoustic interactions with the sub-bottom. The area of interest was limited to the North Atlantic and North Pacific Oceans. A disproportionate number of references deal with the North Atlantic, especially its western region. This is a result of the amount of research carried out in this area, with subsequent journal publications. Because oceanic sedimentation is simple in neither theory nor observation (on the scale of interest), references were chosen that either discussed the general principles of oceanic sedimentation thoroughly or described in detail the sediments in a specific region. Particular emphasis was placed on finding references with mapped data because of its more general utility in typical applications. Without prejudice, only references in English were included. It should be recognized, however, that the Russian literature is copious and thorough, especially for the northern and far northwestern Pacific Ocean. Even with the above disclaimers, anyone interested in the acoustic properties of sediment anywhere in the deep North Atlantic and North Pacific Oceans should be able to find at least one reference covering the area of interest, and those interested in related topics should be able to find several references within the lists of references given for the general topic.

II. ORGANIZATION

The general order of subjects under each topical heading and subheading is one or more of the following: general to specific, abstract to concrete, or surface to great depth. The topical headings are organized randomly. More general material on a specific matter is often referenced under the general topical heading, though not necessarily under the subheading of specific interest; thus, both the general topical heading and subheading references should be searched for pertinent material. Under every topic and subtopic, the references are organized by geographic region.

Composition

The bibliographic cross-reference system consists of twelve topical headings, most with numerous subdivisions. The following topical headings are discussed.

1. Study Locations (by Geographic Region)
2. Study Locations (by Latitude and Longitude)
3. Seafloor Spreading
4. Cores
5. Seismic Reflection and Refraction
6. Detailed Bathymetry
7. Maps
8. Cross Sections
9. Geological History
10. Processes of Sedimentation and Deposition
11. Post-depositional Effects
12. Sediment and Rock Properties

1. Study Locations (by Geographic Region) is divided according to the ocean or sea of the reference. The North Atlantic and North Pacific Oceans are further subdivided into eastern and western regions. The finest scale subdivision is the specific physiographic province covered by the reference. Categories within the hierarchy are not mutually exclusive; i.e., a reference that appears under a specific physiographic province will also appear under a general heading that includes the specific province. However, a general treatment of an area that includes a specific province will not be listed as a reference under that province, even though it would probably be good for background.

2. Study Locations (by Latitude and Longitude) is simply a list of all the detailed study areas, whose center points have been sorted in order of increasing westwardness; thus, $0^{o}E$ would be first, increasing to $180^{o}E$, and thence to $180^{o}W$, finally reaching $0^{o}W$. Latitude is used as a secondary sorting key, placing entries with the same centerpoint longitude in order of increasing northwardness. In the rare case where entries share the same centerpoint coordinates, yet do not cover the exact same area, the entries are sorted in order of increasing alphabetic position. The latitude range is expressed as south-to-north and the longitude range is west-to-east. This corresponds to bottom-to-top, left-to-right, for maps in standard orientation. Thus, entry (A1 $4^{o}N,30^{o}E$) comes before entry (A1 $4^{o}N,170^{o}W$), (A1 $4^{o}N,30^{o}E$) comes before (A1 $5^{o}N,30^{o}E$), and (A1 $4^{o}N,30^{o}E$) comes before (A2 $4^{o}N,30^{o}E$).

3. Seafloor Spreading is arbitrarily divided into four headings which cover aspects of global tectonics that affect the general sediment distribution in the oceans as a function of time. The first heading, Controls on Sediment Types and Depositional Environments, includes references dealing with large scale controls, both on sediment types (such as water depth, temperature, carbonate production rates, and terrigeneous sediment influences) and deposition environments (such as gross current properties and bottom slope angles).

The second heading, Deduced Past Crustal Motions, includes references dealing with large scale sediment variations caused by crustal plate motions. For example, the degree of carbonate productivity in the oceans looks roughly like a series of belts parallel to the equator, which implies that a piece of crust that moves north-south will record a very different sequence of sediments than one that moves east-west, even if both are currently at the same latitude.

The third heading, Depth versus Age Relationship of Oceanic Crust, includes references dealing with large scale changes in depth with time of particular structural features and depositional environments. For example, new crust formed at the ridge of a spreading center is usually shallow enough for preservation of much carbonate deposition. But, as the former ridge crest is pushed away by newer crust it subsides, often exceeding the carbonate compensation depth, and thus restricting new sedimentation to abyssal red clays. Therefore, a typical bottom-to-top arrangement would be volcanics-carbonates-clay.

The fourth heading, Effects on Gross Crustal Structure, includes references dealing with gross bathymetry of the oceanic floor as produced by seafloor spreading. Generally, a cross section oriented normal to the ridge at the spreading center axis shows a trench-abyssal plain-ridge sequence, more or less bilaterally symmetric about the spreading center.

4. Cores is divided into eight sections which cover the various aspects of global core analysis. In the first section, cores are catalogued according to general and specific studies enabling the user to verify existence of core studies in a particular area of interest. The next two sections are divided into comprehensive deep core studies and comprehensive shallow core studies. The last five sections are specific site studies for: Deep Sea Drilling Project, Piston Cores, Gravity Cores, Continental Offshore Stratigraphic Tests, and other core types.

5. Seismic Reflection and Refraction is divided into four sections. The first section includes data processing and modeling of seismic reflection and refraction studies and sonobuoy analyses. The second section includes high frequency echo sounder data for the 3.5-12 kHz range. The third section includes single channel and multichannel low frequency seismic reflection data in all the areas under consideration. High and low frequency refraction data, as well as sonobuoy data, are included in the final section.

6. Detailed Bathymetry is given for all areas under consideration.

7. Maps: The map bibliography is cross-referenced under 29 sections. Studies of carbonate compensation depth (the level below which calcium carbonate forms less that 10% of the sediment) and hysocline (the depth which separates well preserved from poorly preserved assemblages of plautotonic, pteropod, and coccolith) organisms are provided as useful information on sedimentation trends of biologically active areas. Hydrographic data includes current directions and velocities, as well as useful information not directly associated with sedimentation, such as salinity profiles. The gross structure of the oceans (major topographic features) are included on several maps, but can also be found in a separate category along with physiographic provinces. Sedimentation maps fall into several categories. Sediment processes include general sedimentation and surface erosion, as well as sedimentation rates and surface turbidite and debris flow processes. Maps depicting world surface sediment type distribution (including surface volcanic ash and surface sedimentary structures) are referenced.

Surface sediment property maps include grain size analyses, silica and carbonate distribution, and density measurements. In addition to the near-surface sedimentary structure maps, areal distributions of deep acoustic reflectors are cited, along with general sediment layer thickness distributions. Maps of special geological interest include areal distribution of oceanic crust, compressional wave

velocity distribution of ocean crust, gravity and magnetic anomalies, and heat flow distributions.

Survey locations include (PDR) track lines, reflection and refraction lines, sonobuoy stations, and cross sections.

8. Cross Sections: Geological cross sections are useful in the analysis of ocean substructure and in determination of geoacoustic parameters. Geoacoustic profiles are often the result of geological interpretation.

This heading has seven sections. Cross sections are referenced from the view of generalized, schematic representations to analyses of specific cross sections. Undetailed cross sections depicting sedimentation in the deep ocean and on the oceanic ridges are included. References are also cited containing velocity structures inferred from seismic refraction.

The section on lithostratigraphy cites references which deal with the physical characteristics of sedimentary features which change both vertically and laterally. The purpose of lithostratigraphy is to describe and organize these changes systematically into distinctive units. Lithologic units are differentiated according to types such as limestone, sand, biogenic ooze, etc. From the standpoint of layering studies, lithostratigraphic knowledge is perhaps the most important, particularly in the determination of geoacoustic parameters.

Interpreted seismic reflection lines are also referenced and give much information on the layering of oceanic sedimentation.

Core correlations from deep drilling and shallow coring give excellent information, but are limited to small areas.

Int rpreted [illegible] lines are also referenced.

9. Geological History: The heading is divided into four sections according to geologic era: (1) Paleozoic, (2) Mesozoic, (3) Cenozoic, and (4) Pleistocene and Post-Pleistocene. This information is useful for those who are engaged in correlation of layering structures. Often geoacoustic information may be obtained by indirect extrapolation of information on one area to another area based on a knowledge of common geological history.

10. Processes of Sedimentation and Deposition: The eight sections of this heading treat sedimentary processes according to either the type of sediment involved or general processes such as current effects or sedimentation rates. Sediments are classified and referenced as terrigenous (land derived), biogenic (siliceous and calcareous), volcanic, and turbidite and debris flow sediments.

11. The Post-depositional Effects heading has five sections. The papers are referenced with respect to their specificity; the more general treatments are referenced first, with specific effects cited last. General compaction processes, lithification, and diagenetic effects are treated in the first section. Compaction and lithification deal with the process of group, formation, member, and bed assemblages in lithostratigraphic sequences. Diagenetic processes involve physical and chemical changes in sediment after deposition that convert it to consolidated rocks. These processes include compaction, cementation, recrystallization, and replacement, in addition to others. The following two sections reference papers which deal specifically with the subjects of carbonate and silica compaction, lithification, and diagenesis. The last two sections are limited to the special processes of manganese module formulation and the formation of iron rich crusts.

12. Sediment and Rock Properties is divided into eight sections which treat the petrological and sedimentological properties of the ocean sub-bottom, with special emphasis on acoustics. The first section addresses the subject of models of physical properties of sediments. Although velocity and density models are emphasized in the papers cited,

other properties such as porosity, grain size, and other environmental parameters are discussed. The second section references papers which discuss fine scale and coarse scale lithostratigraphy. The next three sections cite papers on the subjects of acoustic properties of sedimentary structures, the origin and nature of acoustic reflectors (general), and the origin and nature of major acoustic reflectors (specific examples). Specific observations of physical properties of sediments are dealt with in the sixth section, which also overlaps considerably with the first section. Lateral variations in physical properties of the ocean sub-bottom and variations of lithology with respect to time are discussed in papers referenced in the final two sections.

III. USER'S GUIDE FOR

BIBLIOGRAPHIC CROSS-REFERENCE SYSTEM

IV. BIBLIOGRAPHIC CROSS-REFERENCE

1. STUDY LOCATIONS
(BY GEOGRAPHIC LOCATIONS)

WORLD: (General Studies, Syntheses, Models of the World Ocean)

General and Specific Studies:

B5, B7, B10, B11, C1, C3, D6, G1, G2, G4, H2, H3, H4, H19, K2, L2, L4, M3, M10, M12, N1, N2, P4, P5, R3, V1, W1, W2, W4.

ATLANTIC OCEAN

NORTH ATLANTIC OCEAN: (Regional and Central Atlantic Studies)

General and Specific Studies:

A1, B1, B6, D4, D6, D7, D8, E1, E2, E8, E10, E17, E18, E19, E20, G5, H6, H11, H15, L5, L7, M1, N5, R4, R5, R6, S2, T1, T2, T3.

Mid-Atlantic Ridge:	E20, M1, V3

NORTH ATLANTIC OCEAN, EAST

General and Specific Studies:

D3, E3, E4, E6, E8, E11, E14, H13, J1, J3, M8, S6, S11, V5.

Alboran Basin:	E8
Arctic Ocean:	E14
Barents Sea:	E3
Canary Basin:	E6
Greenland Sea:	D3, E4, E14
Madeira Rise:	E8, E11
Moroccan Rise:	J3

Norwegian Sea:	D3, E4, E14, H13, S6
Rockall Trough:	S11

NORTH ATLANTIC OCEAN, WEST

General and Specific Studies:

A2, B2, B3, D1, D2, D5, D6, E1, E3, E5, E7, E8, E12, E13, E15, H8, H9, H12, H16, J4, J5, K4, M8, M14, P2, R2, S1, S6, S8, S9, S10, S13, T3, T4, T5, T6, T7, T8, T9, V4, W3.

Amazon Cone:	E8
Bahamas:	E13, E15
Bermuda Rise:	E7, E13, E15, S1, T9
Blake Plateau:	E13, P2
Blake-Bahama Abyssal Plain:	P2
Blake-Bahama Outer Ridge:	H8
Columbus Basin:	P2
Grand Banks:	E8
Greater Antilles Outer Ridge:	T9
Guiana Basin:	D5
Hatteras Abyssal Plain:	E5, H12, P2, S9, T4
Hatteras Outer Ridge:	A2
Hispaniola-Caicos Basin:	B3, P2
Hudson Canyon:	E3, E15
Iceland Basin:	D6
Labrador Sea:	D6
Mid-Ocean Canyon:	E15
Nares Abyssal Plain:	T4, T9
Navidad Basin:	P2, S8
St. Croix Basin:	P2
Silver Abyssal Plain:	P2, V4
Sohm Abyssal Plain:	H12, P2, S13
Tongue of the Ocean:	P2
Whiting Basin:	B2

SOUTH ATLANTIC OCEAN

General and Specific Studies:

B1, E8, E19, L5, R5, R6.

PACIFIC OCEAN

NORTH PACIFIC OCEAN: (Regional and Central Pacific Studies)

General and Specific Studies:

A1, B6, C5, D4, D6, D7, D8, E1, E17, H1, H2, H5, H7, H10, H11, H14, H17, L7, L8, M8, M13, S2, S3, S12, V2, W5.

Central Equatorial:	B6, D6, H17, L7, L8, M8, M13, V2
Magellan Rise:	S3

NORTH PACIFIC OCEAN, EAST

General and Specific Studies:

E9, H5, H7, L3, L6, M4, M5, M6, M7, P2, R1, S4, T10, W6.

Aleutian Basin:	S4
Bering Sea:	H5, R1, S4
Carnegie Ridge:	T10
Clarion Fracture Zone:	H7
Clipperton Fracture Zone:	E9
Panama Basin:	W6
San Diego Trough:	T10
Santa Monica Basin:	P2

NORTH PACIFIC OCEAN, WEST

General and Specific Studies:

B8, B9, C2, C4, E21, F1, F2, H5, H18, J2, J6, J7, K5, L1, M8, M11, N3, N4, P1, P3, S5, T10.

Bonin Trough:	J2
Coral Sea:	M8, M11
Japan Sea:	H5

Meiji Sediment Tongue: S5
Nauru Basin: L1
Obruchev Swell: S4
Ontong-Java Plateau: B8, B9, F2, J6, J7, K5, M11
Shatsky Plateau: C2
Shatsky Rise: E21, P3

SOUTH PACIFIC OCEAN
General and Specific Studies:
E16, T10, W5.

Bauer Basin: E16
Samoan Passage: T10

OTHER REGIONS

INDIAN OCEAN
General and Specific Studies:
A1, D4, H5, K3, M8, R6, S2.

Bay of Bengal: H5

CARIBBEAN SEA
General and Specific Studies:
E1, E12, E15, M8, S6.

MEDITERRANEAN SEA
General and Specific Studies:
A1, H13, M8, R6.

GULF OF MEXICO
General and Specific Studies:
E8, E12, M8.

Mississippi Fan: E8

2. STUDY LOCATIONS
(BY LATITUDE AND LONGITUDE)

	Location of Center	Latitude Range	Longitude Range
M8	21.0°N,0.0°E	0.0°N- 42.0°N	30.0°W- 30.0°E
D3	70.5°N,0.0°E	60.0°N- 81.0°N	30.0°W- 30.0°E
H13	51.5°N,8.0°E	30.0°N- 73.0°N	22.0°W- 38.0°E
E3	73.6°N,31.0°E	69.2°N- 78.0°N	15.0°E- 46.0°E
H5	9.0°N,89.0°E	2.0°S- 20.0°N	80.0°E- 98.0°E
H5	42.3°N,135.5°E	37.0°N- 47.6°N	130.0°E-141.0°E
E21	44.0°N,138.0°E	24.0°N- 64.0°N	105.0°E-171.0°E
J2	27.5°N,141.5°E	26.0°N- 29.0°N	140.0°E-143.0°E
P3	35.0°N,157.5°E	30.0°N- 40.0°N	150.0°E-165.0°E
B9	1.5°N,158.0°E	4.0°S- 7.0°N	153.0°E-163.0°E
K5	5.0°S,160.0°E	20.0°S- 10.0°N	140.0°E-180.0°E
J7	0.5°S,160.0°E	4.0°S- 3.0°N	155.0°E-165.0°E
N3	48.0°N,161.0°E	39.0°N- 57.0°N	140.0°E-178.0°W
L1	5.5°N,165.5°E	2.0°N- 9.0°N	162.0°E-169.0°E
S5	53.0°N,166.0°E	48.0°N- 58.0°N	156.0°E-176.0°E
C4	46.0°N,167.5°E	36.0°N- 56.0°N	154.0°E-179.0°W
H5	55.0°N,175.0°E	50.0°N- 60.0°N	160.0°E-170.0°W
R1	57.0°N,175.0°E	50.0°N- 64.0°N	160.0°E-170.0°W
S3	8.0°N,180.0°E	7.0°N- 9.0°N	179.0°E-179.0°W
S4	56.0°N,175.0°W	52.0°N- 60.0°N	160.0°E-150.0°W
H10, H14	40.0°N,170.0°W	20.0°N- 60.0°N	130.0°E-110.0°W
T10	10.5°S,169.5°W	14.5°S- 6.5°S	171.8°W-167.2°W
L6	5.0°N,162.5°W	0.0°N- 10.0°N	170.0°W-155.0°W
C5	30.0°N,157.0°W	30.0°N- 30.0°N	157.0°W-157.0°W
M13	8.3°N,153.1°W	8.3°N- 8.4°N	153.1°W-153.0°W
H7	14.0°N,153.0°W	13.9°N- 14.1°N	153.1°W-152.9°W
L3	34.0°N,149.0°W	30.0°N- 38.0°N	151.0°W-147.0°W
E9	6.5°N,146.0°W	3.0°N- 10.0°N	152.0°W-140.0°W
M7	4.0°N,136.0°W	4.0°N- 4.0°N	136.0°W-136.0°W

STUDY LOCATIONS (cont'd)

	Location of Center	Latitude Range	Longitude Range
L8	13.7°N,126.3°W	13.7°N- 13.8°N	126.3°W-126.2°W
T10	31.5°N,124.9°W	31.5°N- 31.6°N	124.9°W-124.0°W
T10	32.5°N,121.5°W	29.0°N- 36.0°N	127.0°W-116.0°W
T10	32.4°N,117.5°W	32.4°N- 32.5°N	117.6°W-117.4°W
E16	14.0°S,103.0°W	17.0°S- 11.0°S	107.0°W- 99.0°W
T10	1.0°S,86.0°W	2.0°S- 0.0°N	87.0°W- 85.0°W
M8	17.5°N,77.5°W	0.0°N- 35.0°N	95.0°W- 60.0°W
E13	27.2°N,77.5°W	23.0°N- 31.4°N	80.2°W- 74.8°W
E15	25.4°N,77.4°W	22.8°N- 28.0°N	80.0°W- 74.8°W
H8	28.3°N,74.4°W	28.2°N- 28.4°N	74.5°W- 74.3°W
W3	24.5°N,74.0°W	24.0°N- 25.0°N	75.0°W- 73.0°W
E8	38.5°N,72.5°W	35.0°N- 42.0°N	76.0°W- 69.0°W
B3	20.8°N,72.3°W	19.6°N- 22.0°N	73.3°W- 71.3°W
S9	33.0°N,71.5°W	32.0°N- 34.0°N	73.0°W- 70.0°W
K4	35.5°N,71.5°W	31.0°N- 40.0°N	78.0°W- 65.0°W
E7	28.7°N,71.0°W	23.0°N- 34.4°N	77.5°W- 64.5°W
E15	38.3°N,70.2°W	35.0°N- 41.6°N	74.4°W- 66.0°W
V4	23.0°N,70.0°W	21.0°N- 25.0°N	72.0°W- 68.0°W
E13	37.8°N,69.9°W	35.6°N- 40.0°N	72.8°W- 67.0°W
S8	20.0°N,69.5°W	19.0°N- 21.0°N	71.0°W- 68.0°W
S1	26.5°N,69.5°W	18.0°N- 35.0°N	82.0°W- 57.0°W
H12	30.5°N,69.5°W	23.0°N- 38.0°N	75.0°W- 64.0°W
A2	35.5°N,69.4°W	34.7°N- 36.3°N	70.8°W- 68.0°W
H9	37.0°N,69.0°W	30.6°N- 44.0°N	78.0°W- 60.0°W
T4	22.0°N,68.0°W	4.0°N- 40.0°N	84.0°W- 52.0°W
T9	22.5°N,67.5°W	18.0°N- 27.0°N	75.0°W- 60.0°W
E15	19.5°N,66.5°W	18.0°N- 21.0°N	69.0°W- 64.0°W
H16	29.0°N,66.0°W	20.0°N- 38.0°N	72.0°W- 60.0°W
E15	32.2°N,64.5°W	31.6°N- 32.8°N	65.3°W- 63.7°W
E13	32.7°N,64.4°W	31.7°N- 33.7°N	65.3°W- 63.5°W

STUDY LOCATIONS (cont'd)

	Location of Center	Latitude Range	Longitude Range
G5	29.5°N,62.0°W	21.0°N- 38.0°N	80.0°W- 44.0°W
H9	41.0°N,62.0°W	36.0°N- 46.0°N	70.0°W- 54.0°W
H9	40.0°N,61.0°W	30.0°N- 50.0°N	80.0°W- 42.0°W
E13	27.5°N,59.0°W	10.0°N- 45.0°N	78.0°W- 40.0°W
E10	11.0°N,55.0°W	9.0°N- 13.0°N	58.0°W- 52.0°W
H12	36.5°N,55.0°W	28.0°N- 45.0°N	70.0°W- 40.0°W
H9	45.0°N,55.0°W	25.0°N- 65.0°N	80.0°W- 30.0°W
E8	4.5°N,46.5°W	3.0°N- 6.0°N	49.0°W- 44.0°W
H12	40.5°N,46.5°W	36.0°N- 45.0°N	53.0°W- 40.0°W
V3	22.6°N,45.9°W	22.1°N- 23.1°N	46.4°W- 45.4°W
D6	56.0°N,44.7°W	52.0°N- 60.0°N	49.4°W- 40.0°W
E15	40.5°N,43.5°W	38.0°N- 43.0°N	46.0°W- 41.0°W
M8	10.5°N,43.0°W	9.0°N- 12.0°N	45.0°W- 41.0°W
D1, D2, M8	5.0°N,42.5°W	10.0°S- 20.0°N	65.0°W- 20.0°W
D5	5.0°N,40.0°W	10.0°S- 20.0°N	60.0°W- 20.0°W
M1	36.8°N,33.3°W	36.8°N- 36.8°N	33.3°W- 33.2°W
M1	35.0°N,32.5°W	25.0°N- 45.0°N	45.0°W- 20.0°W
D6	60.0°N,21.0°W	56.0°N- 64.0°N	30.0°W- 12.0°W
E11	29.0°N,20.5°W	23.0°N- 35.0°N	28.0°W- 13.0°W
V5	20.0°N,20.0°W	5.0°N- 35.0°N	30.0°W- 10.0°W
E8, J1	16.5°N,18.5°W	14.0°N- 19.0°N	21.0°W- 16.0°W
E6, E8	26.5°N,18.5°W	23.6°N- 29.4°N	23.0°W- 14.0°W
J3	30.5°N,13.0°W	27.0°N- 34.0°N	20.0°W- 6.0°W
S11	56.3°N,12.5°W	56.3°N- 56.3°N	12.5°W- 12.5°W
E4	70.5°N,2.5°W	60.0°N- 81.0°N	25.0°W- 20.0°E

3. SEAFLOOR SPREADING

Controls on Sediment Types and Depositional Environments

World:	G1
Atlantic Ocean:	E20, M1, S2, V3
Pacific Ocean:	K5, S2, S4, V2, W5
Indian Ocean:	K3, S2

Deduced Past Crustal Motions

World:	B11
Atlantic Ocean:	E4, S2
Pacific Ocean:	B6, S2, S4, S5, W5
Indian Ocean:	S2

Depth versus Age Relationship of Oceanic Crust

World:	B11
Atlantic Ocean:	B5
Pacific Ocean:	B6

Effects on Gross Crustal Structure

Atlantic Ocean:	E4, K4, N5
Pacific Ocean:	K5, S4, V2

4. CORES

Core Catalogs

General and Specific Studies: S7

Comprehensive Deep Core Studies

World:	C3, L4
Atlantic Ocean:	L5

Comprehensive Shallow Core Studies

World:	M8, N2, P4

Deep Sea Drilling Project Studies

World:	G2, P5, V1, W1, W2
Atlantic Ocean:	A2, E12, J4, J5, N5, R4, R5, R6, S1, S2, T1, T2, T5, V5
Pacific Ocean:	F1, J7, K5, L1, L6, M11, N3, P1, P3, R1, S2, S3, S4, S5, S12, V2, W5
Indian Ocean:	R6, S2
Caribbean Sea:	E12
Mediterranean Sea:	R6

Piston Core Studies

Atlantic Ocean:	(Giant Piston Cores) H8, S11
Atlantic Ocean:	A1, A2, B1, B2, B3, D1, D2, D3, D4, D5, E6, E10, E11, E12, E13, E14, E15, E17, E19, E20, H9, H11, H12, H13, J1, M1, P2, S6, S8, S13, T4, T9, V3, V4, W3
Pacific Ocean:	A1, C4, C5, D4, E9, E17, E21, H7, H10, H11, H14, J2, L3, L6, M5, M6, M7, M13, N3, P2, T10, V2
Indian Ocean:	A1, D4
Caribbean Sea:	E12
Mediterranean Sea:	A1, H13
Gulf of Mexico:	E12

CORES (cont'd)

Gravity Core Studies

Atlantic Ocean:	E7, M1
Pacific Ocean:	H7

Continental Offshore Stratigraphic Test Studies

Atlantic Ocean:	G5, J5, R4

Other Core Types

Atlantic Ocean:	H8
Pacific Ocean:	H7

5. SEISMIC REFLECTION AND REFRACTION

Data Processing and Modeling

Seismic Reflection and Refraction: H19

Sonobuoy: B12, L2

High Frequency Echosounder Data (PDR), 3.5-12 kHz

Atlantic Ocean: A2, D1, D3, D4, D6, E6, E7, E8, E10, E11, E12, E15, E20, H8, H9, J1, J3, L7, M10, T4, V3

Pacific Ocean: B9, D4, D6, E9, H7, J2, L7, L8, M5, M7, M13, T10

Indian Ocean: D4

Caribbean Sea: E12, E15

Gulf of Mexico: E12

Low Frequency Seismic Reflection Data, Single Channel and Multichannel

Atlantic Ocean: A2, E1, E4, E12, E17, E18, E19, E20, G5, H9, H16, K4, N5, R4, S9, S13, T5, T6, W3

Pacific Ocean: C2, E1, E9, E17, E21, F2, H7, H17, H18, J2, K5, L1, L6, M13, P3, R1, S3, S4, S5, S12

Caribbean Sea: E1, E12

Gulf of Mexico: E12

High and Low Frequency Refraction Data, including Sonobuoy Data

Atlantic Ocean: E3, E4, E12, H15, H16, N5, R4, S1, T6

Pacific Ocean: F2, H5, H17, H18, J6, J7, R1, S4

Indian Ocean: H5

Caribbean Sea: E12

Gulf of Mexico: E12

6. DETAILED BATHYMETRY

Atlantic Ocean:	A2, B3, D3, E3, E6, E7, E8, E10, E11, E12, H8, M1, R4, S8, V3, V4, W3
Pacific Ocean:	E9, H5, H7, K5, L6, M13, P3, S5, T10
Indian Ocean:	H5
Caribbean Sea:	E12
Gulf of Mexico:	E12

7. MAPS

Carbonate Compensation Surface and Lysocline

World:	B11
Atlantic Ocean:	B6
Pacific Ocean:	B6

Hydrographic Data (Current Directions and Velocities, etc.)

Atlantic Ocean:	D3, E10, H9, M10
Pacific Ocean:	S5

Gross Structure

Atlantic Ocean:	R4, S2
Pacific Ocean:	S2
Indian Ocean:	S2

Sedimentation (General Processes)

Atlantic Ocean:	E10, E11, H11
Pacific Ocean:	H11, H14

Surface Erosion

Pacific Ocean:	L3

Sedimentation Rates

Atlantic Ocean:	D2, E19
Pacific Ocean:	W5

Physiographic Provinces

Atlantic Ocean:	D1, D2, D3, E4, E7, E10, E12, E15, E19, E20, H9, H11, N5, R4, T4, V4, W3
Pacific Ocean:	H11, M13, S4, S5
Caribbean Sea:	E12, E15
Gulf of Mexico:	E12

MAPS (cont'd)

Surface Sediment Type

World: B5

Atlantic Ocean: D2, D6, E12, E13, H9, H11, H12, J1, M1, R4, V4

Pacific Ocean: D6, H7, H11

Surface Sediment Properties: Grain Size Analyses

Atlantic Ocean: B3, H11, H12

Pacific Ocean: H11, H14

Surface Sediment Properties: Silica Distribution

World: C1

Atlantic Ocean: C1, D6

Pacific Ocean: D6, V2

Surface Sediment Properties: Carbonate Distribution

Atlantic Ocean: R4

Pacific Ocean: V2

Surface Sediment Properties: Density

Atlantic Ocean: H11

Pacific Ocean: H11

Surface Turbidite and Debris Flow Distribution

World: M10

Atlantic Ocean: D6, E6, E8

Pacific Ocean: D6, H10, H14

Surface Ash Distribution

Pacific Ocean: H10, H14

Surface Sedimentary Structures

Atlantic Ocean: A2, E10, E11, E12, J1, J3, M10

Near-Surface Sedimentary Structures: PDR Echo Characteristics

Atlantic Ocean:	D1, D3, D4, H9, J1, M10
Pacific Ocean:	D4, H7, J2
Indian Ocean:	D4

Near-Surface and Deep Acoustic Reflectors: Areal Distribution

Atlantic Ocean:	T5
Pacific Ocean:	E9, M13

Sediment Layer Thicknesses

World:	B5
Atlantic Ocean:	B3, E3, E4, E12, E17, E19, H15, K4, R4, V3, V4
Pacific Ocean:	E17, H18, K5, M13, S5, S12, V2
Caribbean Sea:	E12
Gulf of Mexico:	E12

Age of Oceanic Crust: Areal Distribution

World:	B11

P-Wave Velocity of Oceanic Crust

Atlantic Ocean:	H15

Gravity Anomalies

Atlantic Ocean:	E3, R4

Magnetic Anomalies

Atlantic Ocean:	R4
Pacific Ocean:	L1

Heat Flow

Atlantic Ocean:	R4

Survey Locations: PDR Track Lines

Atlantic Ocean:	D1, D3, E7, E12, J3, L7, V3
Pacific Ocean:	H7, L7, L8, M13, T10

Survey Locations: Reflection Track Lines

Atlantic Ocean:	E4, E12, E19, G5, H16, K4, R4, S9
Pacific Ocean:	E9, H7, H17, H18, K5, R1, S5

Survey Locations: Refraction Lines and Sonobuoy Stations

Atlantic Ocean:	E3, E4, E12, H16
Pacific Ocean:	H5, H17, H18, J7, R1
Indian Ocean:	H5

Survey Locations: Cross Sections

Atlantic Ocean:	J5
Pacific Ocean:	S4, V2

DSDP Sites

World:	P5, V1, W1
Atlantic Ocean:	J5, N5, S1, S2, T1, T5, V5
Pacific Ocean:	J7, L1, P3, R1, S2, S3, S4, S5, S12, V2, W5
Indian Ocean:	S2

Core Locations

Atlantic Ocean:	A1, A2, B1, B3, D2, D4, D5, E7, E10, E13, E14, E15, E17, H9, H12, H13, J1, M1, S6, S8, S13, T2, T4, V3, V4, W3
Pacific Ocean:	A1, C4, D4, E9, E17, E21, F1, H7, H14, L3, L6, M8, M11, M13, N3, P2, T10, V2
Indian Ocean:	A1, D4
Caribbean Sea:	E15, S6
Mediterranean Sea:	A1, H13

8. CROSS SECTIONS

Schematic (Generalized; Without Details)

Sedimentation on Oceanic Ridges (World): B11
Sedimentation in the Deep Ocean (World): G1
Structure of the Mid-Atlantic Ridge: E20
Structure of the Atlantic Basin: E1, J5
Structure of the Pacific Basin: L1

Velocity Structure (Usually Inferred from Seismic Refraction)

Atlantic Ocean: E3, E12, G5, H15, H16, N5, R4
Pacific Ocean: F2, S4
Caribbean Sea: E12

Lithostratigraphy

Atlantic Ocean: B5, E1, E12, S2
Pacific Ocean: S2, S4, V2
Indian Ocean: S2
Caribbean Sea: E12
Gulf of Mexico: E12

Interpreted Seismic Reflection Lines

Atlantic Ocean: A2, E4, E12, E17, E18, E19, E20, G5, H9, H16, K4, R4, S9, S13, T5
Pacific Ocean: E9, E17, E21, H7, J2, K5, L1, L6, P3, R1, S3, S4, S5, S12
Caribbean Sea: E12
Gulf of Mexico: E12

Core Correlations from Deep Drilling

World: W1
Atlantic Ocean: G5
Pacific Ocean: F1

CROSS SECTIONS (cont'd)

Interpreted PDR Lines

Atlantic Ocean:	A2, E6, E7, E8, E10, E11, E12, E15, E20, H8, J1, T4, V3
Pacific Ocean:	B9, E9, H7, J2, L8, M5, M13
Caribbean Sea:	E12, E15
Gulf of Mexico:	E12

Core Correlations from Shallow Coring

Atlantic Ocean:	D2, D4, D5, E14, E15, P2, S8, V4, V5
Pacific Ocean:	C4, D4, P2
Indian Ocean:	D4
Caribbean Sea:	E15

9. GEOLOGICAL HISTORY

Paleozoic

World:	V1
Atlantic Ocean:	E3

Mesozoic

World:	B7, L4, V1, W1
Atlantic Ocean:	E3, E12, J4, J5, L5, N5, R5, R6, S2, T5
Pacific Ocean:	E21, J7, L1, S2, S4

Cenozoic

World:	B7, B10, L4, N2, V1, W1, W2
Atlantic Ocean:	A2, D7, D8, E3, E12, E13, J4, J5, L5, M8, N5, P2, S2, T5
Pacific Ocean:	B8, B9, C5, D7, D8, E9, J7, M6, M8, N3, P3, S2, S4, V2, W5

Pleistocene and Post-Pleistocene

World:	B5
Atlantic Ocean:	B6, D1, D2, D3, D5, E14, E15, H8
Pacific Ocean:	B6, C4, H10

10. PROCESSES OF SEDIMENTATION AND DEPOSITION

Oceanic (Generalized Treatments)

World:	B5, D6
Atlantic Ocean:	D1, D2, D3, D6, E10, E19, H11, L7, M1, V3
Pacific Ocean:	C5, D6, E9, H11, H14, L7
Indian Ocean:	K3

Terrigenous Sedimentation

Atlantic Ocean:	B2
Pacific Ocean:	C4

Carbonate Sedimentation

World:	B4, B11, G1, G2
Atlantic Ocean:	D8
Pacific Ocean:	B8, B9, D8, J7

Siliceous Sedimentation

World:	C1, G1, P5

Volcanogenic Sedimentation

World:	N2
Atlantic Ocean:	S13
Pacific Ocean:	N3

Turbidites and Debris Flows

World:	K2, M10, P4
Atlantic Ocean:	B3, E5, E6, E8, E13, H12, J1, J3, P2
Pacific Ocean:	P2

PROCESSES OF SEDIMENTATION AND DEPOSITION (cont'd)

Current Effects

World:	K2
Atlantic Ocean:	E2, E7, E11, H6, H8, H9, J3

Sedimentation Rates

World:	W2
Atlantic Ocean:	D7, D8, E19
Pacific Ocean:	D7, D8

11. POST-DEPOSITIONAL EFFECTS

Generalized Compaction, Lithification, and Diagenetic Effects: G4, L4

Carbonate Compaction, Lithification, and Diagenesis

World:	G2, M12, N1
Pacific Ocean:	M6, M11, S3

Silica Compaction, Lithification, and Diagenesis (including Chertification)

World:	C1, G1, K1, P5
Atlantic Ocean:	V5

Formation of Manganese Nodules: M9

Formation of Iron Rich Crusts: M8

12. SEDIMENT AND ROCK PROPERTIES

Models of Physical Properties of Sediments (especially Velocity and Density)

World:	B12, G3, G4, H2, H3, H4, H19, L2, M2, M3, R3, S14, W4
Atlantic Ocean:	A1, H15, H16, K4, N5, R4, S2, T6
Pacific Ocean:	A1, H2, H5, H17, H18, J6, J7, M5, R1, S2, S3, S4, S12, T10, W6
Indian Ocean:	A1, H5, S2
Mediterranean Sea:	A1

Lithostratigraphy (Both Fine Scale and Coarse Scale)

World:	L4
Atlantic Ocean:	E1, E4, E12, E17, J5, K4, M14, N5, P2, R4, R5, R6, S8, T5, V3, V5
Pacific Ocean:	E1, E17, K5, L1, P2, S4, S5, W6
Indian Ocean:	R6
Mediterranean Sea:	R6

Acoustic Properties of Sedimentary Structures

Atlantic Ocean:	D1, D3, D4, J3, L7
Pacific Ocean:	D4, J2, L7, L8, M13
Indian Ocean:	D4

Origin and Nature of Acoustic Reflectors

Atlantic Ocean:	D1, D3, D4, E18, S11
Pacific Ocean:	B9, D4, E9, H7, H18, K5, M4, M5, M7
Indian Ocean:	D4

Origin and Nature of Major Acoustic Reflectors

Atlantic Ocean:	E1, E12, L5, M14, S9, S10, T3, T7, T8, W3
Pacific Ocean:	E1, R1

SEDIMENT AND ROCK PROPERTIES (cont'd)

Observations of Physical Properties of Sediments

World:	C1, C3, G2, H3, H4, N1, N2, P4, P5, R3, W1, W4
Atlantic Ocean:	A1, B2, B3, E7, E12, E15, E17, H9, H11, H12, H13, L7, R2, R4, R6, S1, S6, S8, T4, T9, V3, V4, V5
Pacific Ocean:	A1, B8, E9, E17, F2, H1, H10, H11, H14, L3, L6, L7, M6, M7, M11, M13, N3, N4, P1, P3, S3, T10, V2
Indian Ocean:	A1, R6
Mediterranean Sea:	A1, H13, R6

Lateral Variations in Physical Properties

Atlantic Ocean:	B2
Pacific Ocean:	T10

Variations in Lithology versus Time

Atlantic Ocean:	T1, T2

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